

DOE/OR-1082

**Type B Investigation of the  
Contamination Accident at the  
BVLLW Upgrade Project  
Discovered on  
December 29, 1992**

**Oak Ridge National Laboratory**

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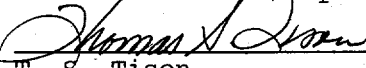
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**March 1993**

*ChemRisk Document No. 1341*

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This document has been reviewed for  
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## DISCLAIMER

This investigative report of the contamination accident reported at the Oak Ridge National Laboratory (ORNL) on December 29, 1992, is an independent product of the Type B Investigation Board (Board) appointed by the Deputy Manager of the Department of Energy's (DOE's) Oak Ridge Field Office (OR) on December 31, 1992.

The Board was appointed to investigate the circumstances surrounding the accident and determine the direct, contributing, and root causes of the accident.

The discussion of the facts as determined by the Board and the views expressed in the report do not assume, and are not intended to establish, the existence of any duty at law on the part of the United States Government, its employees or agents, contractors, their employees or agents, or subcontractors at any tier, or any other party.

This report neither determines nor implies liability.

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## ACRONYMS

BVLLW	Bethel Valley Liquid Low-Level Waste
CAT	Collection and Transfer
CEDE	Committed effective dose equivalent
DOE	Department of Energy
EOC	Emergency Operations Center
HP	Health Physics
HVAC	Heating, Ventilation, and Air Conditioning
LLW	Low-level radioactive waste
LSS	Laboratory Shift Superintendent
MCS	Monitoring and Control Station
MK-F	MK-Ferguson of Oak Ridge
MORT	Management Oversight and Risk Tree
OR	Oak Ridge Field Office
ORNL	Oak Ridge National Laboratory
ORPS	Occurrence Reporting System
P&E	Plant and Equipment Division
PVC	Polyvinylchloride
QA	Quality Assurance
R&D	Research and Development
RMAL	Radioactive Materials Analytical Laboratory
S&H	Safety and Health
SME	Stewart Mechanical Enterprises, Inc.
TAE	Tennessee Associated Electric, Inc.
TCC	Tomahawk Construction Company
TDEC	Tennessee Department of Environment and Conservation
TEMA	Tennessee Emergency Management Agency
TLD	Thermoluminescent detector

## EXECUTIVE SUMMARY

### *Introduction*

On Tuesday, December 29, 1992, several workers at the Oak Ridge National Laboratory (ORNL) Bethel Valley Liquid Low-Level Waste (BVLLW) Upgrade Project \* were discovered to be contaminated after performing construction activities at a new but not yet operating radioactive waste collection facility. Waste drains from an operating radioanalytical laboratory had been connected to the new waste receiving facility in early December. Radioactive waste was inappropriately introduced into the new but not yet authorized laboratory drain system, and was later released into the construction site during installation of valve instrumentation in the drain line. At the end of the shift on December 29, 1992, it was discovered that several workers had become contaminated. Some potentially contaminated workers had already departed the site. These workers were recalled, surveyed, and where necessary, decontaminated. On December 31, 1992, a Type B Investigation Board was appointed by the Deputy Manager of DOE-OR to investigate and report on the accident.

### *Accident Description*

The Monitoring and Control Station (MCS), which is a part of BVLLW Upgrade Project, is intended to receive low-level radioactive waste (LLW) from the Radioactive Materials Analytical Laboratory (RMAL) in Building 2026. Workers came in contact with radioactive contamination in the tank and valve vault areas of the MCS. They were not aware of their contamination until the end of the work shift, at approximately 5:00 p.m., when employee comments regarding liquid seen coming from a cut pipe in the MCS tank vault were overheard by a fellow employee who recommended those workers be checked for contamination before leaving the ORNL Site. Several workers were found to be contaminated when surveyed, and efforts were initiated to recall all those potentially contaminated workers who had left the site.

The sequence of events indicates that radioactive waste was inappropriately introduced into a new drain line leading to the MCS and came in contact with construction workers. Through sampling and analysis, it was determined that radioactive waste was introduced into the new drain system through a new cup sink drain in Laboratory 100 in Building 2026.

\*Managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under contract DE-AC05-84OR21400.

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The Investigation Board interviewed over 30 individuals, but did not determine the specific person or persons who physically put LLW into the Building 2026 new drain system. No evidence was found to indicate that it was an intentional act. Through analysis of gathered evidence, the Board determined that LLW was placed into the new drain system on or after December 10, 1992. The Board determined that there were a number of management systems that failed, which, if they had functioned properly, would have prevented the contamination accident. The direct, contributing and root causes are summarized below.

*Direct, Contributing, and Root Causes*

The direct cause of the accident was the introduction of liquid low-level radioactive waste into the new drain system in Building 2026, Laboratory 100, which leads to the MCS where construction personnel were working. The new drain system was not ready for authorized use.

The Investigation Board deemed the elements organized below into four categories to be the contributing causes.

*Risk Assessment*

- Martin Marietta Energy Systems, Inc. (Energy Systems), Project Team Management did not adequately address the hazards of the "tie-in" of the new drain system to the active laboratory.
- Personnel were not separated by time and space from the hazardous material.

*Job Safety Analysis*

- A project safety analysis of the "tie-in" was not adequately performed.
- The MK-Ferguson of Oak Ridge (MK-F) Safety & Health (S&H) plans were less than adequate.
- The Tomahawk Construction Company (TCC) Safety & Health Plan was less than adequate.
- Ongoing review and update of safety concerns were less than adequate.

*Conduct of Operations*

- Barrier selection was less than adequate.
- Building 2026 Conduct of Operations for radioactive waste disposal during construction was less than adequate.
- Lockout/Tagout control of physical barriers was less than adequate.



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*Management and Oversight*

- Integration and coordination of construction and laboratory operations were less than adequate.
- Construction worker monitoring and training were less than adequate.
- Safety oversight was less than adequate.
- Roles and responsibilities were not clearly understood nor were they fully executed.

In the judgement of the Investigation Board, the root causes of the accident were the following:

- Energy Systems Project Management failed to identify the hazards and properly analyze job safety.
- Energy Systems and MK-F project and line management failed to apply Conduct of Operations principles related to personnel protection.
- OR, Energy Systems, and MK-F failed to provide proper safety oversight.

**Judgement of Needs**

In summary, OR, Energy Systems, MK-F, and TCC management should review their health and safety programs to ensure a safe working environment for employees involved in concurrent operations and construction activities. This review should be an integral part of every phase of a construction project, from initial planning through operation. Risk assessment of tie-ins to operating areas should be performed to understand and respond to potential vulnerabilities. Where a need for barriers is identified, conformance of the barrier to applicable standards should be assured. Responsibility for barriers should be clear, and administrative controls should be communicated effectively.

Line management should continually monitor to ensure that Conduct of Operations principles are applied to critical activities such as waste disposal, including Lockout/Tagout, administration of safety barriers, and safety oversight. For a complex project organization to function, effective communication and coordination is imperative.

Project Management should place a special emphasis on Conduct of Operations during concurrent construction and operations activities.

## 1. SCOPE OF INVESTIGATION

A Type B Investigation Board (Board) was appointed by the Deputy Manager of the DOE-OR to investigate the December 29, 1992, contamination accident at the BVLLW Project at ORNL. The Board was charged with three tasks: (1) determine the direct, contributing, and root causes of the accident; (2) prepare a report on the accident (this document, DOE/OR-1082) in accordance with DOE Order 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements; and (3) provide recommendations to prevent similar occurrences. Formal memoranda of appointment are included here as Appendix A.

The Board reviewed and analyzed physical evidence from the scene of the accident; interviewed key witnesses; held discussions with Energy Systems, MK-F, TCC, and TCC subcontractor personnel and employees; and reviewed and evaluated documentation. The Board used methods prescribed in the DOE accident investigation protocols, including the Events and Causal Factors Chart, Barrier Analysis, and the Management Oversight and Risk Tree (MORT) techniques to ensure evaluation completeness.

The Board focused its review on those OR, Energy Systems, MK-F, and TCC management systems, physical equipment, and procedures and practices (actual activities as well as associated documentation) directly related to the contamination accident.

## 2. FACTS

### 2.1 BACKGROUND INFORMATION

#### 2.1.1 General Description of the ORNL Site

ORNL is one of three major facilities in Oak Ridge, Tennessee, operated for DOE by Energy Systems. Founded during World War II under the code name X-10, ORNL supported the mission of the Manhattan Project to produce the world's first nuclear weapons. Since that time, ORNL has become one of the nation's largest multiprogram national laboratories. An organization chart for ORNL is presented in Appendix B.

#### 2.1.2 Current Activities at the ORNL Site

Activities at ORNL are focused on basic and applied research, technology development, and other technological challenges that are important to DOE and to the Nation. ORNL also performs research and development (R&D) for non-DOE sponsors when such activities complement DOE missions and address important national or international issues.

The mission of ORNL is to support DOE in six broad areas: energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

Since its origination in 1942, ORNL has remained a major center for research, development, and production missions that involve the use of a wide array of radioactive and hazardous materials. In support of these missions, special facilities were constructed to manage the radioactive and hazardous waste materials, some of which are still in use today. Among those facilities is an underground liquid-waste collection and transfer (CAT) system that serves the entire laboratory. After 40 years of operation, much of the original CAT system has reached its life expectancy and is showing signs of deterioration. In addition, state and federal regulatory requirements are more restrictive on underground systems that handle radioactive and hazardous liquid wastes. The 40-year old CAT system does not have the features necessary for compliance with these regulations. Consequently, a new double-contained, monitorable, high-integrity collection and transfer system for handling ORNL liquid low-level radioactive waste was proposed to effectively replace and retire portions of the existing system.

### 2.1.3 BVLLW Upgrade Project Activities

The BVLLW Project was conceived to replace a portion of the old CAT system. As part of the BVLLW Project, liquid low-level waste (LLW) lines external to Building 2026 would be replaced, the MCS (Building 2099) would be constructed, and LLW waste piping internal to Building 2026 would be replaced (See Exhibit 1 for the general location within ORNL). The MCS facility (See Exhibit 2) will be used to collect and neutralize liquid radioactive wastes generated within Building 2026 in a collection tank and periodically transfer the collected waste to an evaporator. Construction began on the MCS in July 1991 and was to have been completed in early 1992, but is still underway.

The MCS facility consists of an underground double-contained hastelloy piping system which transfers LLW generated within Building 2026 into a below-grade stainless steel collection tank. The collection tank is located in a stainless steel-lined concrete vault (See Model, Exhibit 3). Valves for the collection tank are located in an adjacent stainless steel-lined concrete valve vault. Located above grade and adjacent to the below-grade vault structures are a concrete control room for the MCS, heating, ventilation, and air-conditioning (HVAC) equipment located on a concrete pad, a stainless steel ventilation stack, a caustic storage tank in a concrete block structure, and a truck unloading station for the caustic tank.

### 2.1.4 Organizational Relationships

The BVLLW Project Team consists of OR, Energy Systems, MK-F, TCC, and other subcontractors as defined in the Project Management Plan (See Exhibit 4).

OR furnishes overall project management, including oversight of all Title I, II, and III documents; administers all prime contracts; and directs and administers all aspects of the project, including specific approval of work assignments and approval of work performed. All project participants are under contract to OR or its contractors.